



MOTOROLA

Advance Information

Micropower smallCAP™ Voltage Regulators with On/Off Control

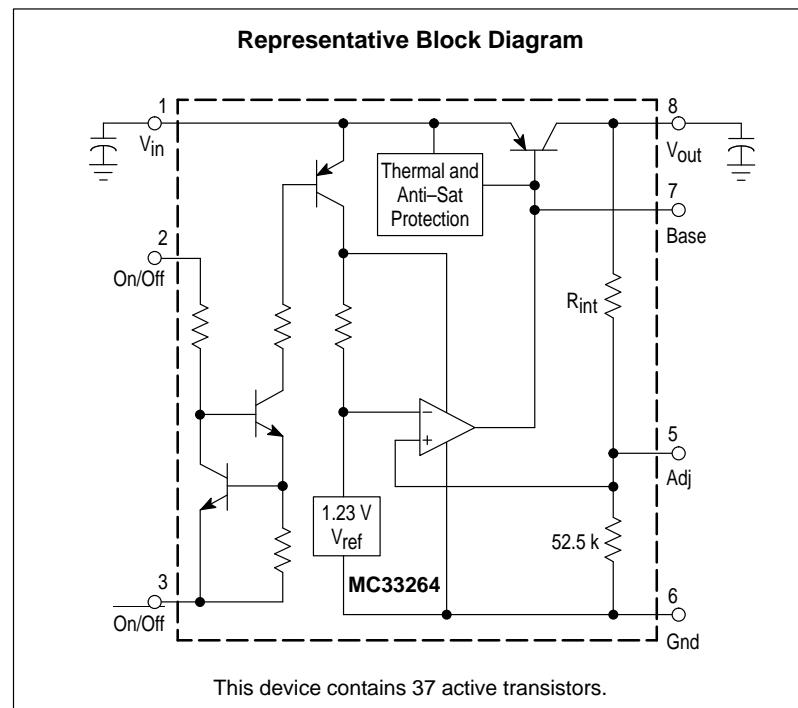
The MC33264 series are micropower low dropout voltage regulators available in SO-8 and Micro-8 surface mount packages and a wide range of output voltages. These devices feature a very low quiescent current (100 µA in the ON mode; 0.1 µA in the OFF mode), and are capable of supplying output currents up to 100 mA. Internal current and thermal limiting protection is provided. They require only a small output capacitance for stability.

Additionally, the MC33264 has either active HIGH or active LOW control (Pins 2 and 3) that allows a logic level signal to turn-off or turn-on the regulator output.

Due to the low input-to-output voltage differential and bias current specifications, these devices are ideally suited for battery powered computer, consumer, and industrial equipment where an extension of useful battery life is desirable.

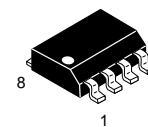
MC33264 Features:

- Low Quiescent Current (0.3 µA in OFF Mode; 95 µA in ON Mode)
- Low Input-to-Output Voltage Differential of 47 mV at 10 mA, and 131 mV at 50 mA
- Multiple Output Voltages Available
- Extremely Tight Line and Load Regulation
- Stable with Output Capacitance of Only 0.22 µF for 4.0 V, 4.75 V and 5.0 V Output Voltages 0.33 µF for 2.8 V, 3.0 V, 3.3 V and 3.8 V Output Voltages
- Internal Current and Thermal Limiting
- Logic Level ON/OFF Control
- Functionally Equivalent to TK115XXMC and LP2980

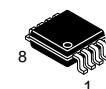
**MC33264**

LOW DROPOUT MICROPOWER VOLTAGE REGULATORS WITH ON/OFF CONTROL

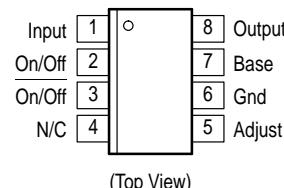
SEMICONDUCTOR TECHNICAL DATA



D SUFFIX
PLASTIC PACKAGE
CASE 751
(SO-8)



DM SUFFIX
PLASTIC PACKAGE
CASE 846A
(Micro-8)

PIN CONNECTIONS**ORDERING INFORMATION**

Device	Operating Temperature Range	Package
MC33264D-2.8		SO-8
MC33264D-3.0		
MC33264D-3.3		
MC33264D-3.8		
MC33264D-4.0		
MC33264D-4.75		
MC33264D-5.0		
MC33264DM-2.8	T _A = -40° to +85°C	
MC33264DM-3.0		
MC33264DM-3.3		
MC33264DM-3.8		
MC33264DM-4.0		
MC33264DM-4.75		
MC33264DM-5.0		

MC33264

MAXIMUM RATINGS ($T_C = 25^\circ\text{C}$, unless otherwise noted.)

Rating	Symbol	Value	Unit
Input Voltage	V _{CC}	13	Vdc
Power Dissipation and Thermal Characteristics			
Maximum Power Dissipation	P _D	Internally Limited	W
Case 751 (SO-8) D Suffix	R _{θJA}	180	°C/W
Thermal Resistance, Junction-to-Ambient	R _{θJC}	45	°C/W
Thermal Resistance, Junction-to-Case			
Case 846A (Micro-8) DM Suffix	R _{θJA}	240	°C/W
Thermal Resistance, Junction-to-Ambient			
Output Current	I _O	100	mA
Maximum Adjustable Output Voltage	V _O	1.15 x V _{nom}	Vdc
Operating Junction Temperature	T _J	125	°C
Operating Ambient Temperature	T _A	-40 to +85	°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

NOTE: ESD data available upon request.

ELECTRICAL CHARACTERISTICS ($V_{in} = 6.0 \text{ V}$, $I_O = 10 \text{ mA}$, $C_O = 1.0 \mu\text{F}$, $T_J = 25^\circ\text{C}$ (Note 1), unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Output Voltage ($I_O = 0 \text{ mA}$) 2.8 Suffix ($V_{CC} = 3.8 \text{ V}$) 3.0 Suffix ($V_{CC} = 4.0 \text{ V}$) 3.3 Suffix ($V_{CC} = 4.3 \text{ V}$) 3.8 Suffix ($V_{CC} = 4.8 \text{ V}$) 4.0 Suffix ($V_{CC} = 5.0 \text{ V}$) 4.75 Suffix ($V_{CC} = 5.75 \text{ V}$) 5.0 Suffix ($V_{CC} = 6.0 \text{ V}$) $V_{in} = (V_O + 1.0) \text{ V}$ to 12 V, $I_O < 60 \text{ mA}$, $T_A = -40^\circ$ to $+85^\circ\text{C}$ 2.8 Suffix 3.0 Suffix 3.3 Suffix 3.8 Suffix 4.0 Suffix 4.75 Suffix 5.0 Suffix	V _O	2.74 2.96 3.23 3.72 3.92 4.66 4.9	2.8 3.0 3.3 3.8 4.0 4.75 5.0	2.86 3.04 3.37 3.88 4.08 4.85 5.1	V
Line Regulation ($V_{in} = [V_O + 1.0] \text{ V}$ to 12 V, $I_O = 60 \text{ mA}$) All Suffixes	Regline	—	2.0	10	mV
Load Regulation ($V_{in} = [V_O + 1.0]$, $I_O = 0 \text{ mA}$ to 60 mA) All Suffixes	Regload	—	16	25	mV
Dropout Voltage $I_O = 10 \text{ mA}$ $I_O = 50 \text{ mA}$ $I_O = 60 \text{ mA}$	V _I - V _O	— — —	47 131 147	90 200 230	mV
Quiescent Current ON Mode ($V_{in} = [V_O + 1.0] \text{ V}$, $I_O = 0 \text{ mA}$) OFF Mode ON Mode ($V_{in} = [V_O + 0.5] \text{ V}$, $I_O = 0 \text{ mA}$) [Note2]	I _Q	— — —	95 0.3 540	150 2.0 900	μA
Ripple Rejection (V_{in} peak-to-peak = $[V_O + 1.5]$ to $[V_O + 5.5]$ V at $f = 1.0 \text{ kHz}$)	—	55	65	—	dB
Output Voltage Temperature Coefficient	T _C	—	±120	—	ppm/°C
Current Limit ($V_{in} = [V_O + 1.0]$, V_O Shorted)	I _{Limit}	100	150	—	mA
Output Noise Voltage (10 Hz to 100 kHz) (Note 3) $C_L = 1.0 \mu\text{F}$ $C_L = 100 \mu\text{F}$	V _n	— —	110 46	—	μVrms

NOTES: 1. Low duty pulse techniques are used during test to maintain junction temperature as close to ambient as possible.

2. Quiescent current is measured where the PNP pass transistor is in saturation. $V_{CE} = -0.5 \text{ V}$ guarantees this condition.

3. Noise tests on the MC33264 are made with a $0.01 \mu\text{F}$ capacitor connected across Pins 8 and 5.

ELECTRICAL CHARACTERISTICS (continued) ($V_{in} = 6.0$ V, $I_O = 10$ mA, $C_O = 1.0 \mu\text{F}$, $T_J = 25^\circ\text{C}$ (Note 1), unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON/OFF INPUTS					
On/Off Input (Pin 3 Tied to Ground) Logic "1" (Regulator ON) Logic "0" (Regulator OFF)	$V_{On/Off}$	2.4 0	— —	V_{in} 0.5	V
On/Off Input (Pin 2 Tied to V_{in}) Logic "0" (Regulator ON) Logic "1" (Regulator OFF)		0 $V_{in} - 0.2$	— —	$V_{in} - 2.4$ V_{in}	
On/Off Pin Input Current (Pin 3 Tied to Ground) $V_{On/Off} = 2.4$ V	$I_{On/Off}$	—	1.9	—	μA
On/Off Pin Input Current (Pin 2 Tied to V_{in}) $V_{On/Off} = V_{in} - 2.4$ V		—	12	—	

NOTES: 1. Low duty pulse techniques are used during test to maintain junction temperature as close to ambient as possible.
 2. Quiescent current is measured where the PNP pass transistor is in saturation. $V_{CE} = -0.5$ V guarantees this condition.
 3. Noise tests on the MC33264 are made with a 0.01 μF capacitor connected across Pins 8 and 5.

DEFINITIONS

Dropout Voltage – The input/output voltage differential at which the regulator output no longer maintains regulation against further reductions in input voltage. Measured when the output drops 100 mV below its nominal value (which is measured at 1.0 V differential), dropout voltage is affected by junction temperature, load current and minimum input supply requirements.

Line Regulation – The change in output voltage for a change in input voltage. The measurement is made under conditions of low dissipation or by using pulse techniques such that average chip temperature is not significantly affected.

Load Regulation – The change in output voltage for a change in load current at constant chip temperature.

Maximum Power Dissipation – The maximum total device dissipation for which the regulator will operate within specifications.

Quiescent Current – Current which is used to operate the regulator chip and is not delivered to the load.

Output Noise Voltage – The rms ac voltage at the output, with constant load and no input ripple, measured over a specified frequency range.

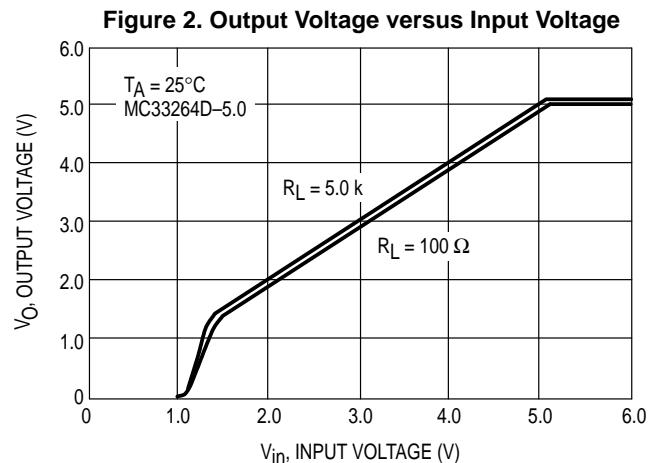
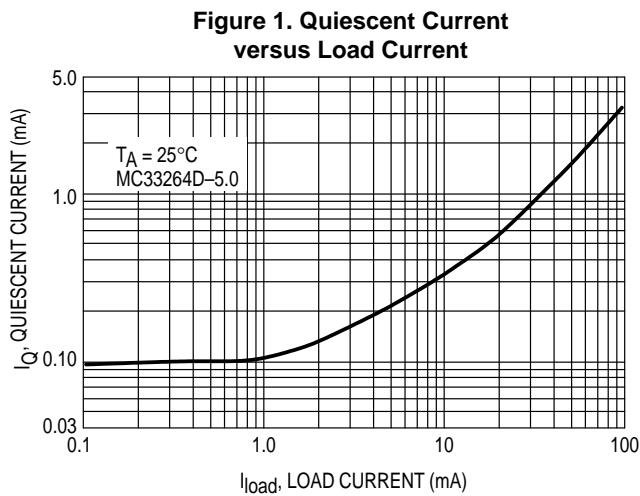
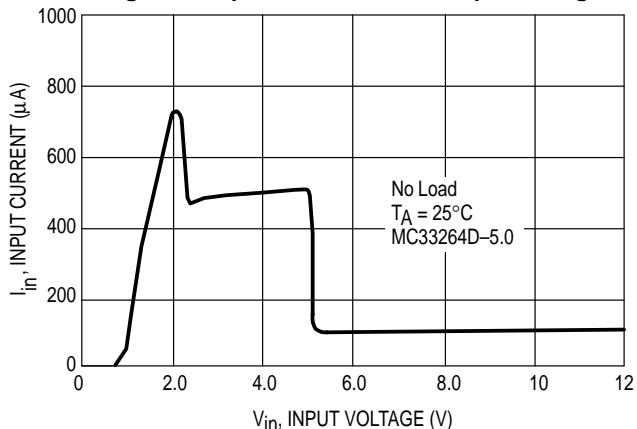
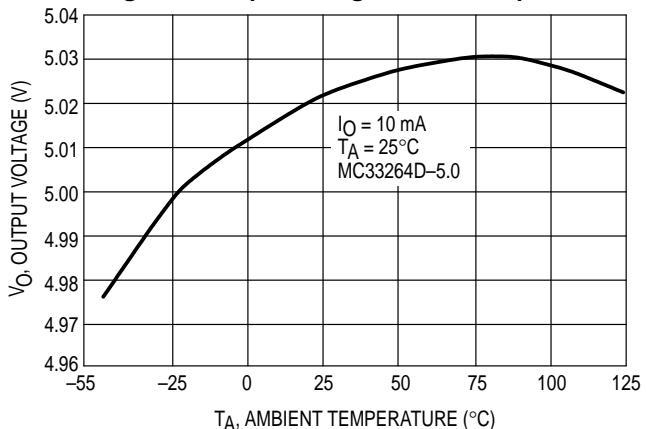
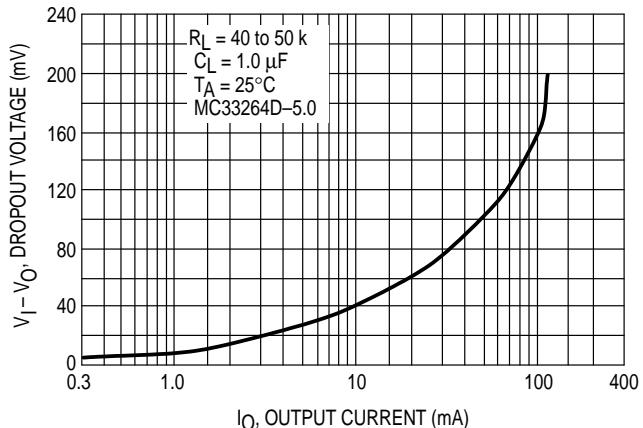
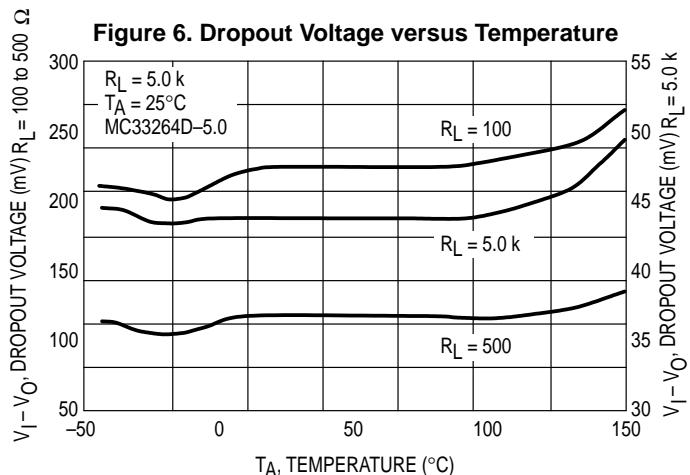


Figure 3. Input Current versus Input Voltage**Figure 4. Output Voltage versus Temperature****Figure 5. Dropout Voltage versus Output Current****Figure 6. Dropout Voltage versus Temperature**

APPLICATION INFORMATION

Introduction

The MC33264 regulators are designed with internal current limiting and thermal shutdown making them user-friendly. These regulators require only 0.33 μ F (or greater) capacitance between the output terminal and ground for stability for 2.8 V, 3.0 V, 3.3 V and 3.8 V output voltage options. Output voltage options of 4.0 V, 4.75 V and 5.0 V require only 0.22 μ F for stability. The output capacitor must be mounted as close to the MC33264 as possible. If the output capacitor must be mounted further than two centimeters away from the MC33264, then a larger value of output capacitor may be required for stability. A value of 0.68 μ F or larger is recommended. Most types of aluminum, tantalum or multilayer ceramic will perform adequately. Solid tantalums or appropriate multilayer ceramic capacitors are recommended for operation below 25°C.

A bypass capacitor is recommended across the MC33264 input to ground if more than 4.0 inches of wire connects the input to either a battery or power supply filter capacitor.

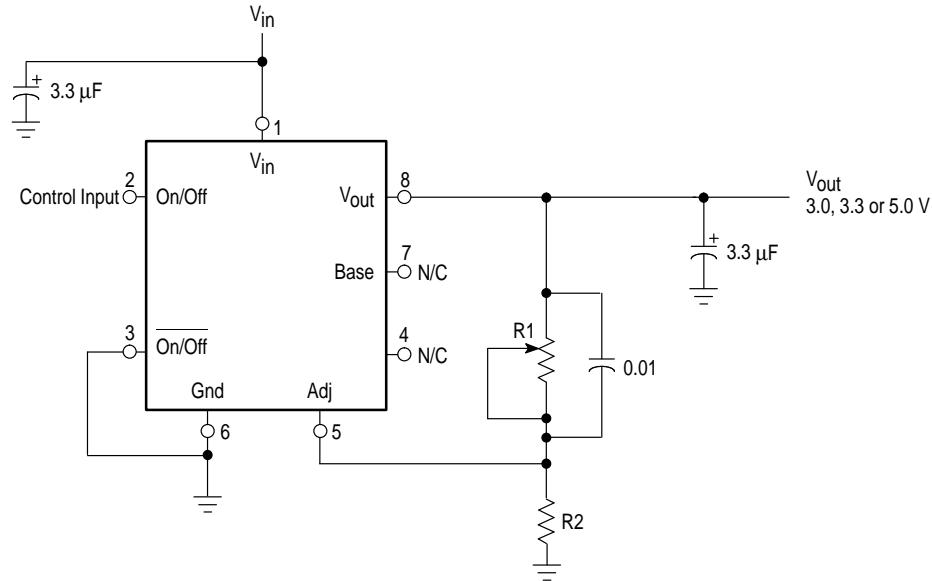
On/Off Control

On/Off control of the regulator may be accomplished in either of two ways. Pin 3 may be tied to circuit ground and a positive logic control applied to Pin 2. The regulator will be turned on by a positive (>2.4 V) level, typically 5.0 V with respect to ground, sourcing a typical current of 6.0 μ A. The regulator will turn off if the control input is a logic "0" (<0.5 V). Alternatively, Pin 2 may be tied to the regulator input voltage and a negative logic control applied to Pin 3. The regulator will be turned on when the control voltage is less than V_{in} - 2.4 V, sinking a typical current of 18 μ A when V_{in} = 6.0 V. The regulator is off when the control input is open or greater than V_{in} - 0.2 V.

Programming The Output Voltage

The MC33264 output voltage is automatically set using its internal voltage divider. Alternatively, it may be programmed within a typical $\pm 15\%$ range of its preset output voltage. An external pair of resistors is required, as shown in Figure 7.

Figure 7. Regulator Output Voltage Trim



The complete equation for the output voltage is:

$$V_{out} = V_{ref} \left(1 + \frac{R_1}{R_2} \right) + I_{FB} R_1$$

where \$V_{ref}\$ is the nominal 1.235 V reference voltage and \$I_{FB}\$ is the feedback pin bias current, nominally -20 nA. The minimum recommended load current of 1.0 \$\mu A\$ forces an upper limit of 1.2 M\$\Omega\$ on the value of \$R_2\$, if the regulator must work with no load. \$I_{FB}\$ will produce a 2% typical error in \$V_{out}\$ which may be eliminated at room temperature by adjusting \$R_1\$. For better accuracy, choosing \$R_2 = 100\$ K reduces this error to 0.17% while increasing the resistor program current to 12 \$\mu A\$.

Output Noise

In many applications it is desirable to reduce the noise present at the output. Reducing the regulator bandwidth by

increasing the size of the output capacitor is the only method for reducing noise.

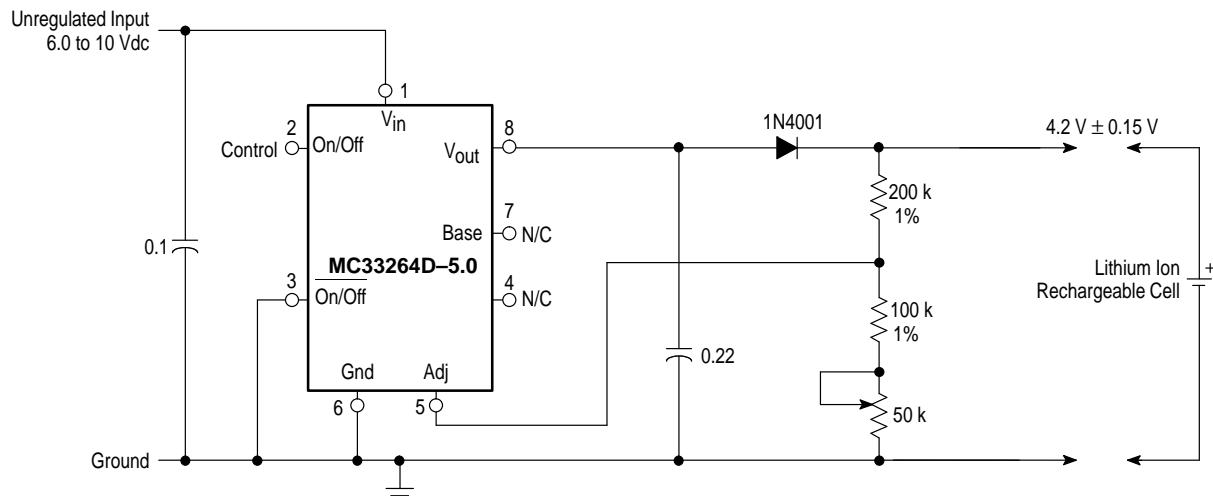
Noise can be reduced fourfold by a bypass capacitor across \$R_1\$, since it reduces the high frequency gain from 4 to unity for the MC33264D-5.0. Pick

$$C_{BYPASS} = \frac{1}{2\pi R_1 \times 200\ Hz}$$

or about 0.01 \$\mu F\$. When doing this, the output capacitor must be increased to 3.3 \$\mu F\$ to maintain stability. These changes reduce the output noise from 430 \$\mu V\$ to 100 Vrms for a 100 kHz bandwidth for the 5.0 V output device. With the bypass capacitor added, noise no longer scales with output voltage so that improvements are more dramatic at higher output voltages.

TYPICAL APPLICATIONS

Figure 8. Lithium Ion Battery Cell Charger



MC33264

Figure 9. Low Drift Current Source

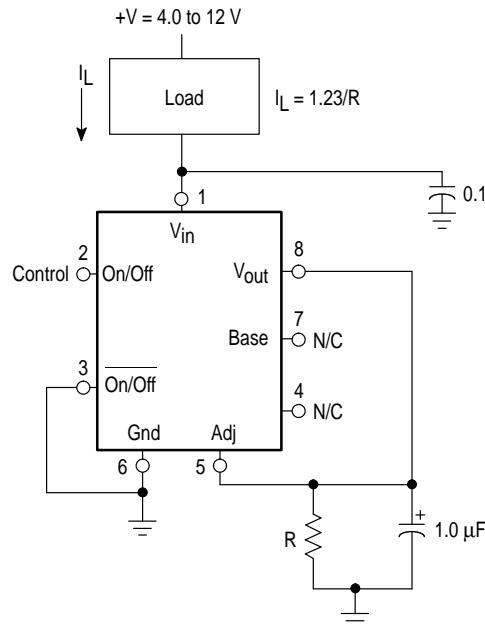
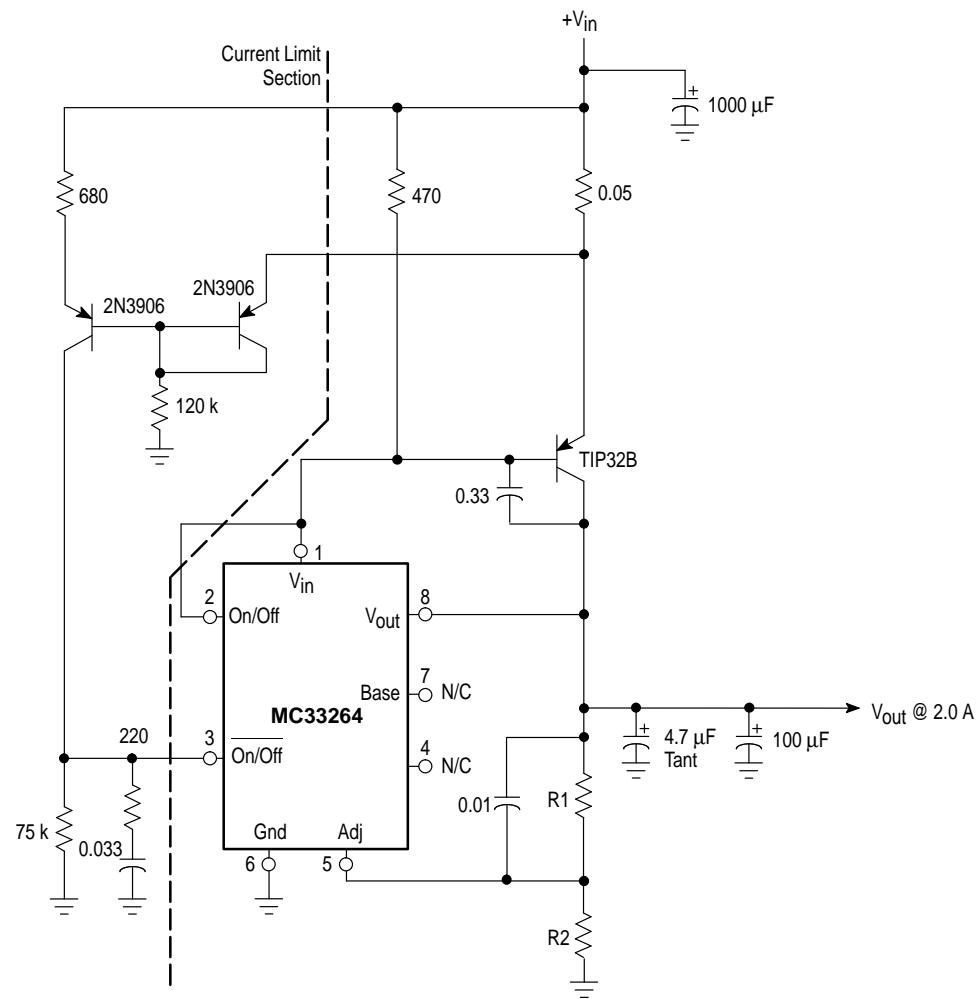


Figure 10. 2.0 Ampere Low Dropout Regulator



MC33264

Figure 11. Low Battery Disconnect

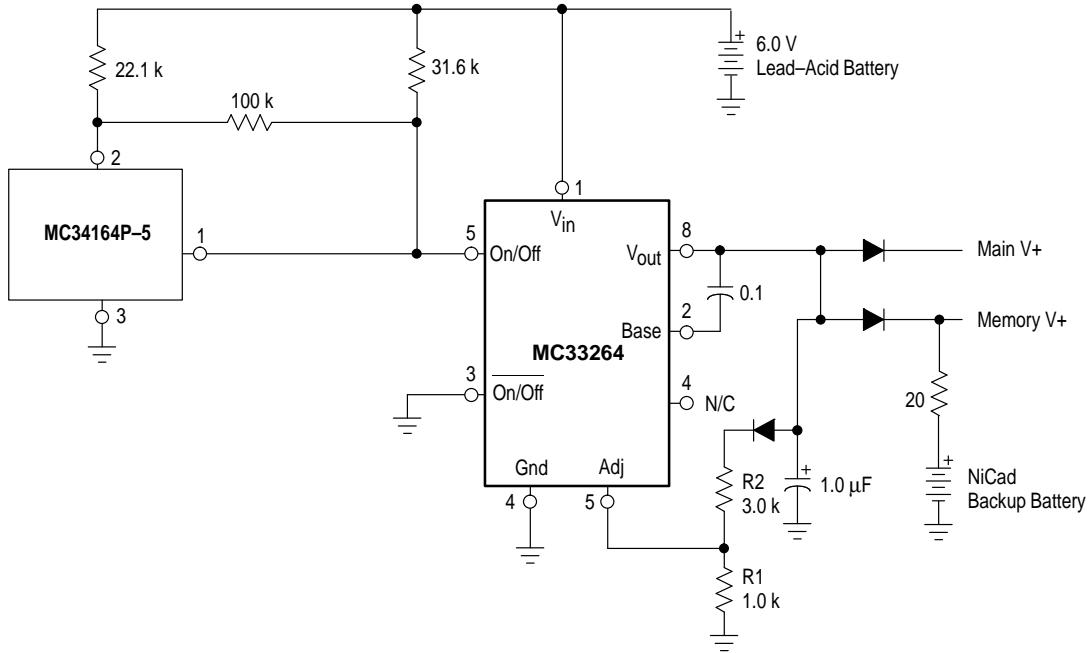
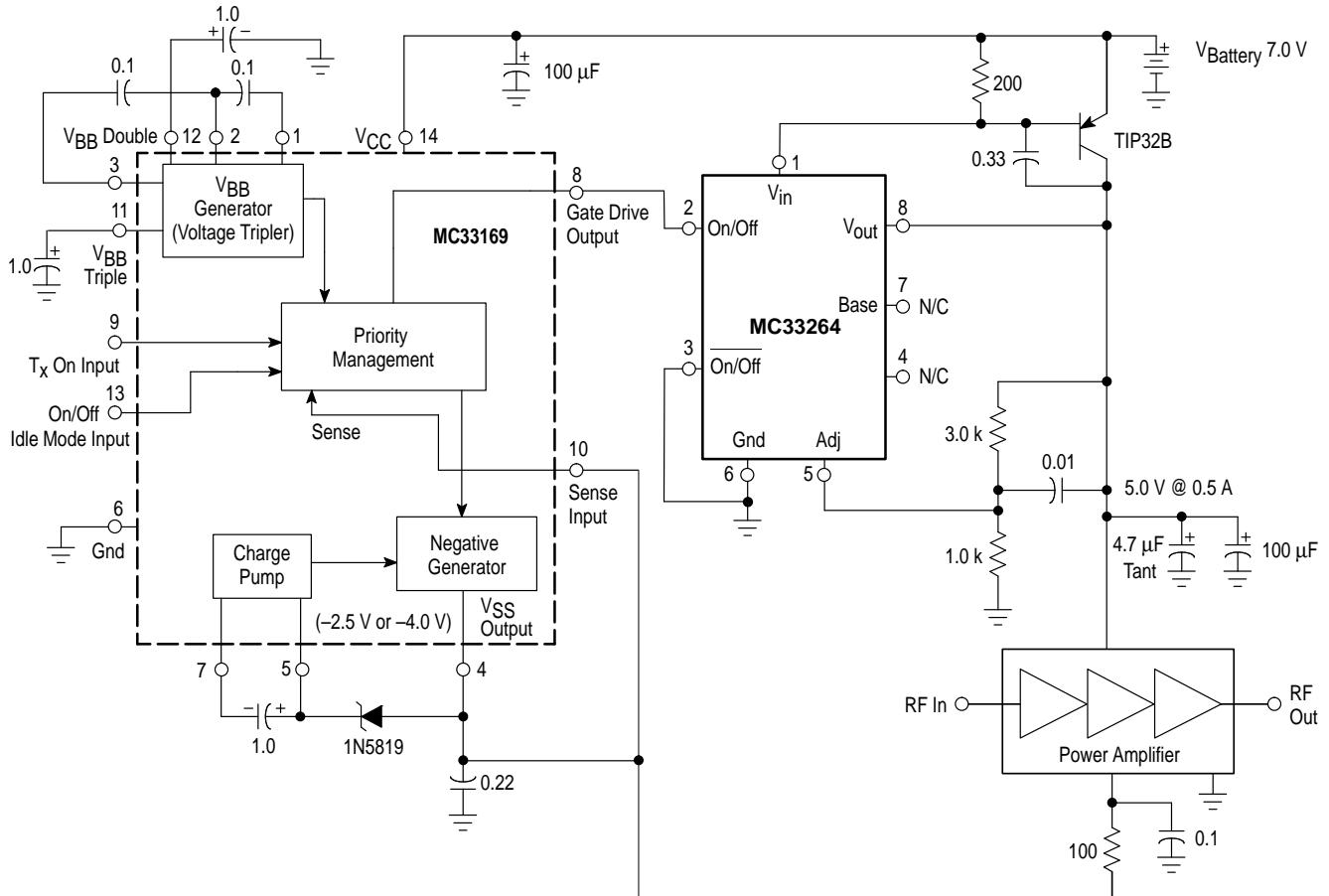


Figure 12. RF Amplifier Supply



OUTLINE DIMENSIONS

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